# AMIP: Approach and Lessons Learned

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# Outline

- AMIP approach and evolution.
- Lessons learned from AMIP and other MIP's.
- Future directions.

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# The Atmospheric Model Intercomparison Project (AMIP)

- Experiment design:
  - ➔ Stand-alone atmospheric model run with realistically prescribed, monthly varying sea surface temperatures and sea ice (1979 – present)
  - ➔ Several well observed parameters specified (e.g. solar constant & orbital parameters, etc.)
- Coordinated by PCMDI with oversight provided by WGNE (a WMO committee).
- Participation: more than 30 modeling groups from around the world have contributed output, some from multiple versions of their models.
- Analysis procedure
  - ➔ Predefined set of model output adhering to community-adopted metadata standards placed in a uniform database
  - ➔ Diagnosis and evaluation performed by modeling groups and a wider community of specialists
  - ➔ Model performance summaries prepared by PCMDI.


# Original AMIP goals

- Evaluate models run under identical experimental conditions
- Identify systematic errors in models
- Attract a broad scientific community to help in analyzing the models.
- Improve models

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# AMIP achievements

- Established AMIP as a benchmark experiment
  - ➔ periodic appraisal of atmospheric models
  - ➔ monitor changes in model performance.
- Determined relative strengths and limitations of individual models.
- Fostered cooperative modeling culture:
  - ➔ Increased camaraderie among participating groups
  - ➔ Increased openness about model flaws
- Exposed flaws in individual models which sometimes led to model improvements.
- Enabled “economies of scale” in model diagnosis and evaluation

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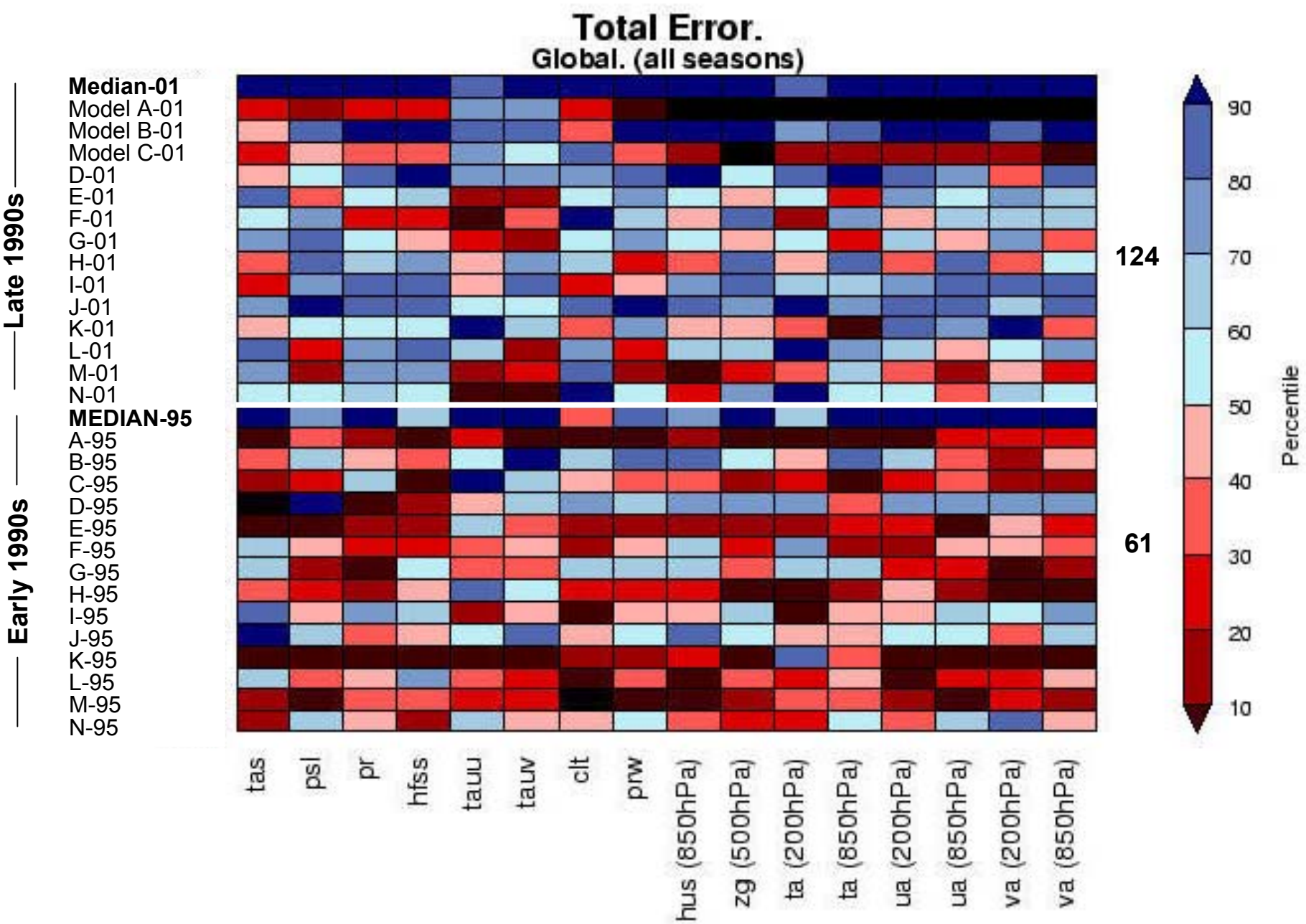
# Lessons from AMIP and other MIP's

- Community consensus on experiment design is essential
- Don't underestimate the work involved in preparing boundary conditions.
- Model output (data) issues should be addressed early.
- Success may depend on obtaining funding specifically to support a project office.
  - ➔ Responsible for project coordination, data collection and distribution, maintaining communications (web site), etc.
  - ➔ Requires major commitment of time from at least one scientist and at least one computer-savvy individual.
- Quick summaries of overall results might best be prepared by members of the contributing groups, but broader community involvement in the analysis of MIP results should be encouraged.

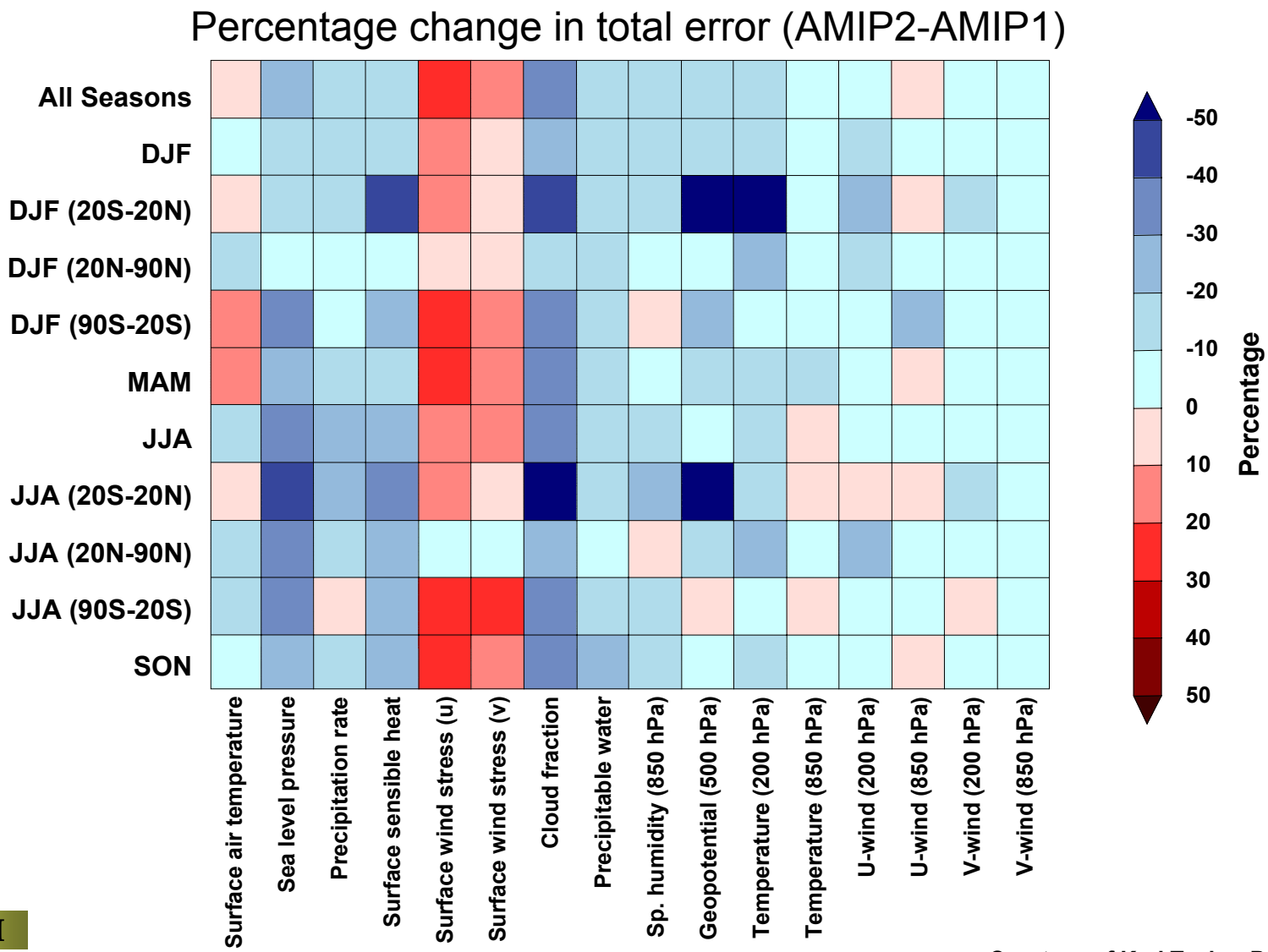
# Generalizations based on AMIP experiments:

- Models are improving.
- Mean or median model results appear to be superior to even the best individual models – model diversity is desirable.
- It is helpful for groups to see how their model compares with others.

# AGCMs are Improving in a Quantifiable Way



# Has the median model improved from AMIP 1 to AMIP 2?

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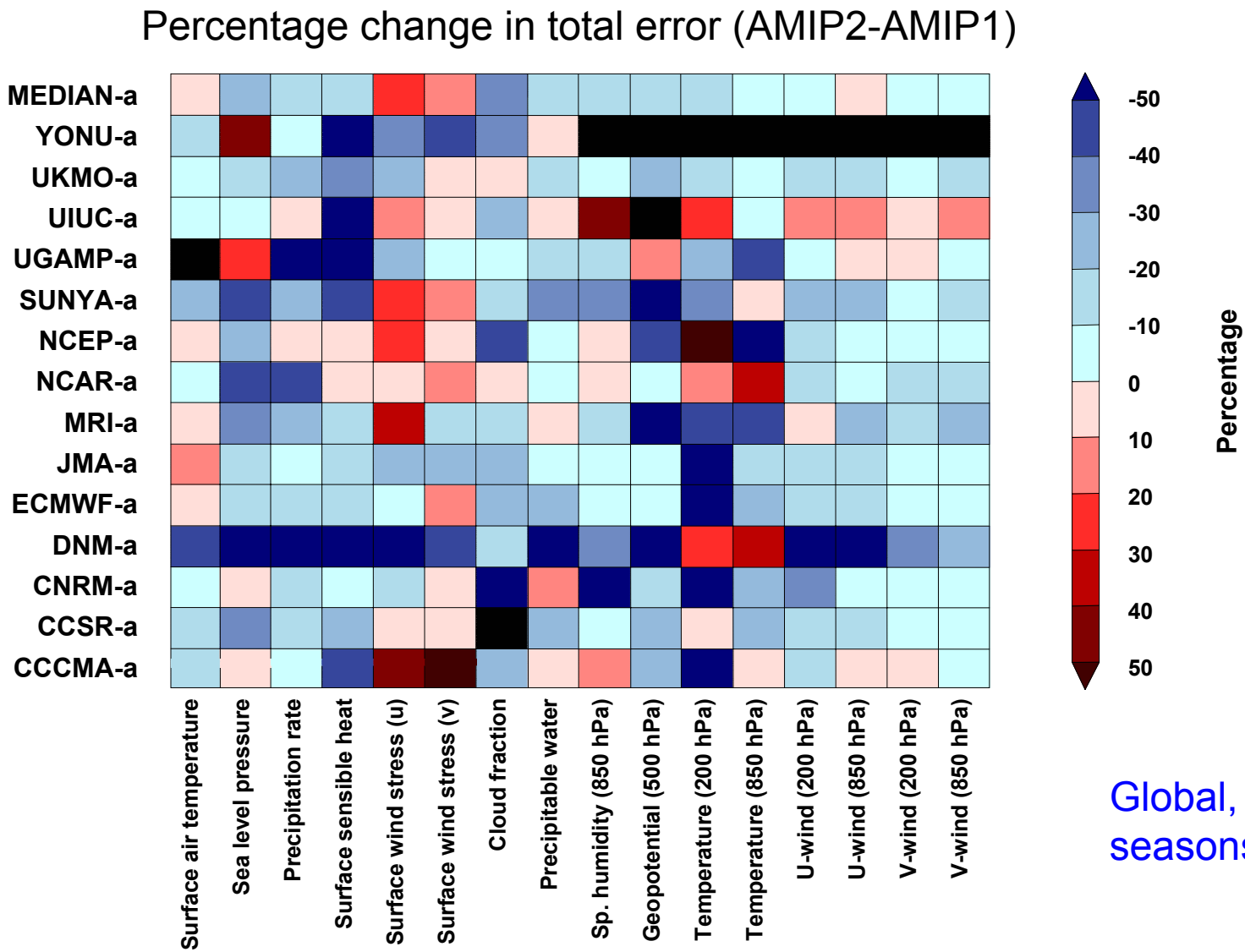
Courtesy of Karl Taylor, PCMDI

# Have individual GCMs improved over the past decade?




Global, all seasons

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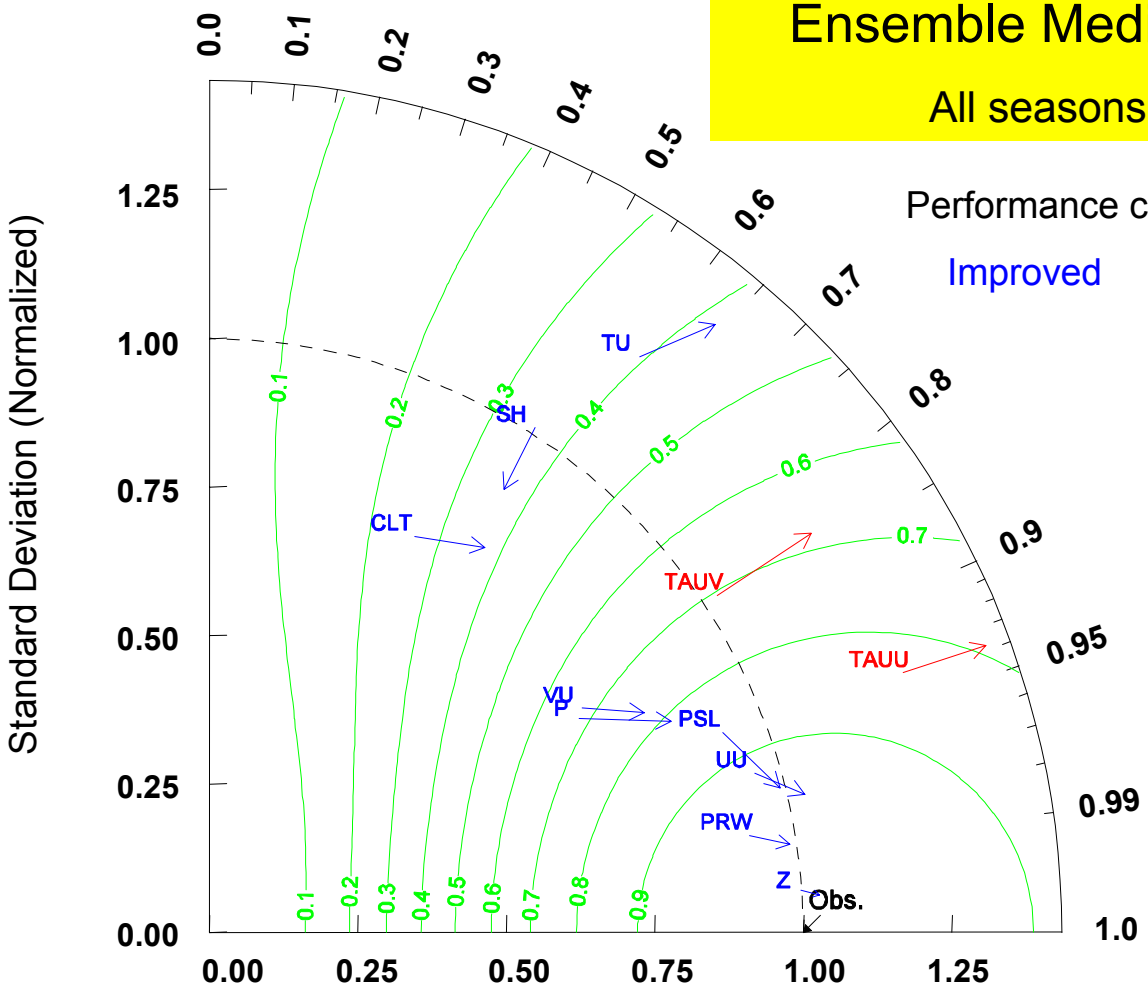
# Have atmospheric GCMs improved over the past decade?




## Ensemble Median (14 models)

All seasons climatology

Performance changes: AMIP 1 to AMIP 2

Improved

Deteriorated

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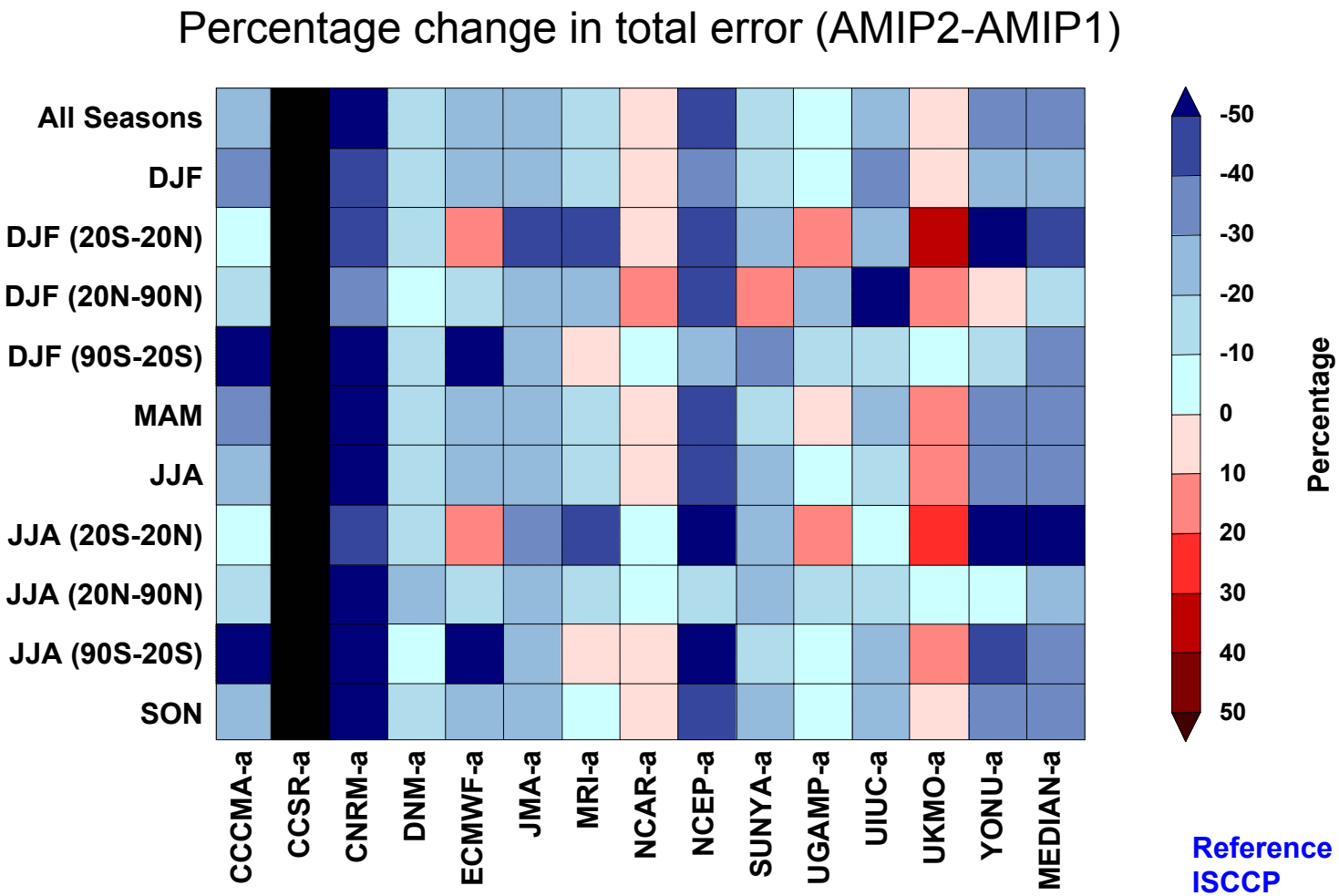
# Have AGCMs improved in their simulation of total cloud cover?



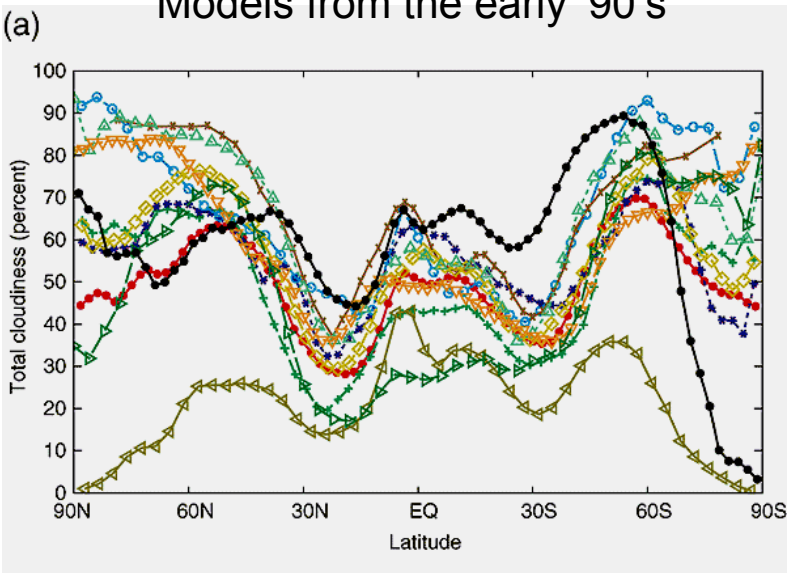

Reference data: ISCCP

Courtesy of Karl Taylor, PCMDI

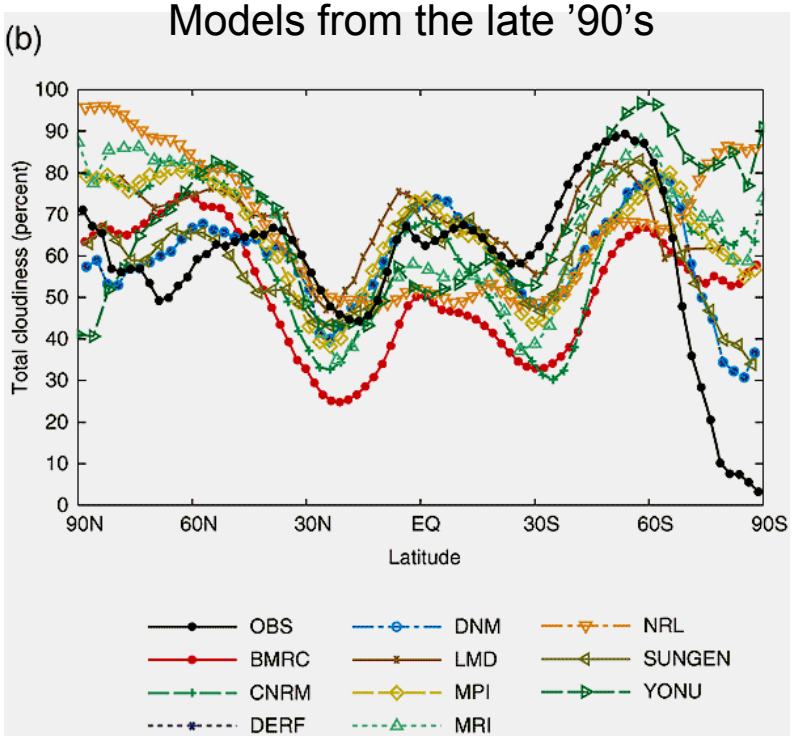
# Errors have been reduced especially in outlier models.

## Cloud Fraction

Models from the early ’90’s




Models from the late ’90’s




From IPCC, 2001

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# The most important practical lesson:

- Impose strict requirements on the format and structure of model output.
- Agree on a set of standard model output.
  - ➔ Do not be overly concerned about amount of data (e.g., ask for monthly samples, not climatological means, or long accumulations)
  - ➔ Ask for some high frequency snap-shots

# There is increasing support for unifying model output across MIP's.

- The IPCC and nearly all MIP's have adopted netCDF as the preferred format for archived data.
- The CF-metadata conventions are required by IPCC and many MIP's.
- Many groups are now using a software library (CMOR) written by PCMDI to rewrite their model output
  - ➔ CMOR satisfies the requirements of IPCC and many MIP's.
  - ➔ CMOR ensures a uniformity in the structure and information included in archived data.

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# What are the CF-Metadata Conventions?

- A standard way of generating a self-describing netCDF file.
- An extension of an earlier, more limited “COARDS” standard.
- It encourages storage of metadata that can be useful in model diagnosis.
- The conventions enable development of common software that can understand model output from diverse sources.
- See http://www.cgd.ucar.edu/cms/eaton/netcdf/CF-working.html


# Metadata accommodated by the CF standard

- data set description: title, institution, source, history, published references
- variable description: standard name, units, dimensions, and indication of dimension type (longitude, latitude, time, etc.)
- axis description: coordinate values and bounds, projection information, averaging information (e.g., climatology)
- missing value identification
- specification of data compression/packing method
- much more

# Future directions – a personal view

- Work toward an integrated set of benchmark experiments
  - ➔ Tests of coupled models and also their components (CMIP, AMIP, OMIP)
  - ➔ Tests at various time-scales (weather , seasonal prediction, climate)
  - ➔ Process intercomparisons coordinated across MIP's (e.g., CMIP/PMIP "water-hosing" experiment, CFMIP to help diagnose CMIP simulations)
- Universal adoption of CF metadata standards for model output
- Gradual evolution toward distributed data bases
- Increased interest of an expanding community of diagnostic specialists.
- Mounting pressure to expose models to scrutiny before accepting their projections for future climate change.
- Reduced infrastructure support required.

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# Concluding thoughts

- Additional complications face an intercomparison project involving predictions of future climate change.
  - ➔ No observations
  - ➔ How do you interpret differences? "uncertainty" or simply "spread"?
- Recommend that regional climate modelers join global modelers in accepting the CF-conventions
- Better yet, use CMOR to structure model output and include metadata that will facilitate analysis of model output by a wide community of researchers.

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